PATENT COOPERATION TREATY

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NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

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Date of mailing (day/month/year) 10 July 2000 (10.07.00)	
International application No. PCT/NO98/00347	**Applicant's or agent's file reference** JGS/BF/129996
International filing date (day/month/year) 25 November 1998 (25.11.98)	**Priority date** (day/month/year)
Applicant MOEN, Morten et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

31 May 2000 (31.05.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

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14

PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
129996/OS/KR		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/NO98/00347	25.11.1998	--
International Patent Classification (IPC) or national classification and IPC7		
H 04 L 12/56		
Applicant		
Telefonaktiebolaget LM Ericsson et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 3 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
31.05.2000	28.02.2001
Name and mailing address of the IPEA/SE	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Telex 17978 PATOREG-S Facsimile No. 08-667 72 88	Roger Bou Faisal/MN Telephone No. 08-782 25 00

Form PCT/IPEA/409 (cover sheet) (January 1998)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/NO98/00347

I. Basis of the report

1. With regard to the **elements** of the international application:*

☐ the international application as originally filed

☒ the description:
pages 1-9 , as originally filed
pages _____ , filed with the demand
pages _____ , filed with the letter of _____

☒ the claims:
pages _____ , as originally filed
pages _____ , as amended (together with any statement) under article 19
pages _____ , filed with the demand
pages 10-12 , filed with the letter of 04.01.2001

☒ the drawings:
pages 1-3 , as originally filed
pages _____ , filed with the demand
pages _____ , filed with the letter of _____

☐ the sequence listing part of the description:
pages _____ , as originally filed
pages _____ , filed with the demand
pages _____ , filed with the letter of _____

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages _____

☐ the claims, Nos. _____

☐ the drawings, sheet/fig _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.*

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/NO98/00347

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-11	YES
	Claims		NO
Inventive step (IS)	Claims	1-11	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-11	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

The invention relates to a method for establishing alternative routes in a telecommunication network, especially in case of transmission failures, and more specifically in a telecommunication network comprising transmission links for duplex operation. The object of the invention is to give a method that is less expensive and more reliable than similar prior art methods.

According to the invention there is suggested a method which is characterised by arranging said network in one or more initial rings including duplex operation between the nodes included in each ring, and by arranging said nodes such as to let all time slots be transmitted in one and the same direction (OK direction) of the ring in question whilst maintaining the opposite direction (ERROR direction) as a standby or redundancy path.

Documents found relevant and cited in the International Search Report:
[D1] WO 9701907, A1
[D2] EP 0370845, A1
[D3] US 5636205, A

D1 relates to a self healing communication node network with main and protection rings and that has link supervision devices for monitoring power on input and output lines and deflecting traffic onto protection ring when failure occurs. The communication node can be used in an optical communication network with a number of nodes operating on a ring basis. The network pref. has a working ring and a protection ring, which can transmit traffic in both directions. The node includes link supervision devices to monitor the power on the input and output fibres. These detect errors or faults causing a break between nodes, using the power measurements. The node also

.../...

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V

includes an optical switch to redirect traffic onto the protection ring. When a fault has been repaired a network management unit communicates with the node to cause it to restore operations onto the working ring. Pref. the node performs redirection through an optical bar and cross switches. The object of the invention is to allow nodes to swiftly detect faults and re-route traffic onto protection nodes without external assistance and a system capable of detecting faults occurring in immediate surroundings (see abstract; page 3, line 25-page 5, line 30 and claims 1-5).

D2 reveals a communication network of the ring type comprising at least one first transmission loop connecting various Cluster Monitoring Units (CMU) to which the various subscribers of the network are connected, characterised in that it comprises a second transmission loop referred to as the spare loop (S) which interconnects the various CMU, and which possesses a transmission direction inverse to that of the first loop (see the whole document).

In D3 there is described a bi-directional line switched ring BLSR network that connects a plurality of nodes in a ring formed by transmission lines. In the network, in normal operation each node sends a subsequent node address contained in an APS byte of the K1 and K2 bytes in a multiplexed signal overhead to the subsequent node. When detecting a trouble of a transmission line, each node adjacent the trouble sends the address of a node normally connected thereto via the troubled line. The bi-directional line switched ring network control system provides each node with a bypass circuit for the APS byte and an address comparison circuit for comparing the address in the APS byte with a current node address. Each node closes the bypass circuit and receives the APS byte when the result of comparison proves coincident, and opens the bypass circuit and allows the passage of the APS byte when the result proves non-coincident (see the whole document).

Document D3 is a state of the art document and is used to give a better perspective for understanding the claimed invention.

The invention according to amended independent claim 1 differs from what is disclosed in D1 or D2 by the procedure of providing a time slot with alternating means adapted to monitor each section in the ring in question for both directions, and said alternating means being defined by the bit configuration of said time slot.

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Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V

It is mentioned in D1 and D2 that a first working ring carries traffic in one transmission direction and a second protection ring is used for traffic in the opposite transmission direction. Also, that the traffic can for example be electric, optical energy or wavelength channels. It is not mentioned in D1 that the network comprises 2 Mbit/s transmission links and nodes with G.704 framing for duplex operation. However, these implementations are considered obvious to a person skilled in the art since many existing optical networks are adapted for broadband transmission and include nodes with duplex operations. A ring node system using time slots and frames is described in the state of the art document D3. Using a TDM network instead of a WDM network is an obvious step.

To summarise:
With reference to D1-D3, the invention according to claims 1-11 is novel, is considered to include an inventive step and to has industrial applicability.

Patent claims
(amended 04.01.2000)

1. Method for establishing alternative routes in a telecommunication network, especially in case of transmission failure, and more specifically in a telecommunication network comprising 2 Mbit/s transmission links and nodes with G.704 framing for duplex operation, wherein said network is arranged in one or more initial rings including duplex operation between the nodes included in each ring, characterized by

- Arranging said nodes, due to the symmetrical nature of the 2 Mbit/s network, such as to let all time slots be transmitted in one and the same direction (OK direction) of the ring in question whilst maintaining the opposite direction (ERROR direction) as a standby or redundancy path until alerted by a specific time slot reflecting the occurrence of a fault,

- Providing a time slot, preferably time slot 0, with alerting means that are adapted to monitor each section in the ring in question for both directions, said alerting means being defined by the bit configuration of said time slot.

2. Method as claimed in claim 1, characterized in that each node is provided with detection means adapted for detecting a section transmission fault both at the incoming or at the outgoing ports thereof, i.e. allowing detection of a transmission fault on a section at both ends of said section.

3. Method as claimed in claim 1 or 2, characterized by letting inter alia the following fault criteria determine the re-routing of the time slots:

LIS - Loss of Incoming Signal

LFA - Loss of Frame Alignment
RAI - Remote Alarm Indication

4. Method as claimed in any of the preceding claims, characterized in that during normal and initial ring operation the timing information will preferably be taken from one of the incoming signals, i.e. signals being propagated along the normal (OK) direction.

5. Method as claimed in any of the preceding claims, characterized in that when a fault occurs on a section in the ring the two nodes at the end of that faulty section will be triggered by one or more appropriate switching criteria, for thereby reconfiguring the two nodes in question for routing the traffic which should have been sent via the faulty section to its destination node or nodes via the duplex channel in the opposite (ERROR) direction.

6. Method as claimed in any of the preceding claims, characterized in that when a fault occurs in a section between two nodes then the node immediately following the faulty section in the previous normal (OK) direction will have its timing source changed upon detection of the appropriate fault occurrence switching criteria, and that any further node or nodes being arranged between said immediately following node and a node (A) being connected to a central node (CN) will also have its or their timing sources changed.

7. Method as claimed in claim 6, characterized in that one of the spare bits in time slot 0 is used as a timing source bit and that on ports being used as a timing source this bit will be given a first state, preferably the high state, whereas all other ports will have the same spare bit sent in the opposite state, i.e. preferably the low state.

8. Method as claimed in claim 7, characterized in that when the node (D) immediately following the faulty section starts using the other non-faulty/redundancy channel port as timing source, then the timing source bit will force the next node (DX) in the redundancy (ERROR) direction to change its timing source if timing was previously taken from said next to fault node (D), which forcing will take place also in any still further nodes (DY, DZ) arranged between said next to fault node (D) and said node (A) being connected to a central node (CN).

9. Method as claimed in any of the preceding claims, characterized in that the transport of the timing change information sent or rippled through nodes involved in a redundancy (ERROR) path, i.e. receiving signals thereon but transmitting signals on the remaining normal (OK) path, is adapted in relation to clock stability requirement so as to avoid the occurrence of bit slip.

10. Method as claimed in any of the preceding claims, characterized in that the method is applied in an autonomous manner, without any interaction with a remote management system (RMS).

11. Method as claimed in any of the preceding claims, characterized in that the method is applied as an autonomous self healing ring, especially in a 2 Mb/s leased line telecommunication network so as to create redundancy pathways therein in case of transmission failure.

Patent claims

1. Method for establishing alternative routes in a telecommunication network, especially in case of transmission failure, and more specifically in a telecommunication network comprising 2 Mbit/s transmission links and nodes with G.704 framing for duplex operation, wherein said network is arranged in one or more initial rings including duplex operation between the nodes included in each ring,
characterized by
- arranging said nodes, due to the symmetrical nature of the 2 Mbit/s network, such as to let all time slots be transmitted in one and the same direction (OK direction) of the ring in question whilst maintaining the opposite direction (ERROR direction) as a standby or redundancy path until alerted by a specific time slot reflecting the occurrence of a fault.

2. Method as claimed in claim 1,
characterized by providing a time slot, preferably time slot 0, with alertable means which are adapted to monitor each section in the ring in question for both directions, said alerting means being defined by the bit configuration of said time slot.

3. Method as claimed in claim 1 or 2,
characterized in that each node is provided with detection means adapted for detecting a section transmission fault both at the incoming or at the outgoing ports thereof, i.e. allowing detection of a transmission fault on a section at both ends of said section.

4. Method as claimed in any of the claims 1-3,
characterized by letting inter alia the following fault criteria determine the re-routing of the time slots:

LIS - Loss of Incoming Signal
LFA - Loss of Frame Alignment
RAI - Remote Alarm Indication

5. Method as claimed in any of the preceding claims,
c h a r a c t e r i z e d i n that during normal and initial ring operation the timing information will preferably be taken from one of the incoming signals, i.e. signals being propagated along the normal (OK) direction.

6. Method as claimed in any of the preceding claims,
c h a r a c t e r i z e d i n that when a fault occurs on a section in the ring the two nodes at the end of that faulty section will be triggered by one or more appropriate switching criteria, for thereby reconfiguring the two nodes in question for routing the traffic which should have been sent via the faulty section to its destination node or nodes via the duplex channel in the opposite (ERROR) direction.

7. Method as claimed in any of the preceding claims,
c h a r a c t e r i z e d i n that when a fault occurs in a section between two nodes then the node immediately following the faulty section in the previous normal (OK) direction will have its timing source changed upon detection of the appropriate fault occurrence switching criteria, and that any further node or nodes being arranged between said immediately following node and a node (A) being connected to a central node (CN) will also have its or their timing sources changed.

8. Method as claimed in claim 7,
c h a r a c t e r i z e d i n that one of the spare bits in time slot 0 is used as a timing source bit and that on ports being used as a timing source this bit will

be given a first state, preferably the high state, whereas all other ports will have the same spare bit sent in the opposite state, i.e. preferably the low state.

9. Method as claimed in claim 8, characterized in that when the node (D) immediately following the faulty section starts using the other non-faulty/redundancy channel port as timing source, then the timing source bit will force the next node (DX) in the redundancy (ERROR) direction to change its timing source if timing was previously taken from said next to fault node (D), which forcing will take place also in any still further nodes (DY, DZ) arranged between said next to fault node (D) and said node (A) being connected to a central node (CN).

10. Method as claimed in any of the preceding claims, characterized in that the transport of the timing change information sent or rippled through nodes involved in a redundancy (ERROR) path, i.e. receiving signals thereon but transmitting signals on the remaining normal (OK) path, is adapted in relation to clock stability requirement so as to avoid the occurrence of bit slip.

11. Method as claimed in any of the preceding claims, characterized in that the method is applied in an autonomous manner, without any interaction with a remote management system (RMS).

12. Method as claimed in any of the preceding claims, characterized in that the method is applied as an autonomous self healing ring, especially in a 2 Mb/s leased line telecommunication network so as to

create redundancy pathways therein in case of transmission failure.

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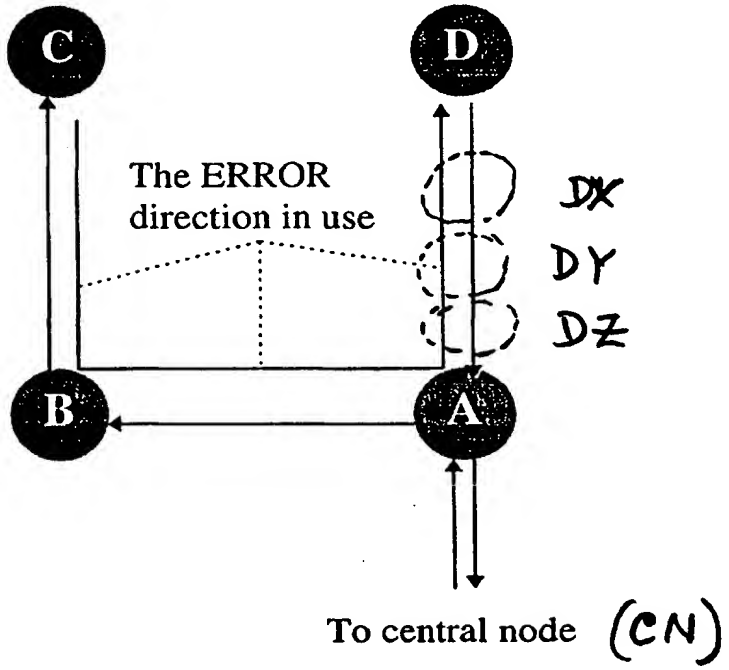
(54) Title: METHOD FOR ESTABLISHING ALTERNATIVE ROUTES IN A TELECOMMUNICATION NETWORK

(57) Abstract

The present invention relates to a method for establishing alternative routes in a telecommunication network, especially in case of transmission failure, and more specifically in a telecommunication network comprising transmission links for duplex operation, less expensive and more reliable than similar prior art methods, it is according to the invention suggested a method which is characterized by: arranging said network in one or more initial rings including duplex operation between the nodes included in each ring; and by arranging said nodes such as to let all time slots be transmitted in one and the same direction (OK direction) of the ring in question whilst maintaining the opposite direction (ERROR direction) as a standby or redundancy path.



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METHOD FOR ESTABLISHING ALTERNATIVE ROUTES IN A TELECOMMUNICATION NETWORK

Field of the invention

The present invention relates to a method for establishing alternative routes in a telecommunication network, especially in case of transmission failure, and more specifically in a telecommunication network comprising transmission links for duplex operation.

More specifically the present invention relates to a method for constructing an autonomous self healing ring in a 2 MBit/s leased line telecommunication network in order to create redundancy in the network in case of transmission failure.

Technical background

THE PROBLEM AREA

The problem area concerns building a transmission network between digital cross-connects in such a way that alternative routes are introduced in case of transmission failures. This is desirable in order to keep the network up and running when failures occur. As described below, earlier solutions have involved expensive dual lines or slow remote management involvement. In certain applications, such as cellular networks, it is important that the solution is at low cost and that the network disturbance does not last so long as to disrupt on-going traffic.

KNOWN SOLUTIONS

Known solutions for providing network protection in a 2 MBit/s telecommunications network include

- 1+1 protection
- N+1 protection
- NMS re-routing
- Ring topologies

1+1 protection uses duplicated lines between nodes. Traffic is sent out identically on both lines, and the receiving node chooses the 'best' line. The entire protection operation including detection of problems and switching of input source is performed at the receiving end. Switching is autonomously and fast and does not include network management system involvement.

N+1 protection adds one extra line to a group of N lines. The stand-by line will take over for any of the other lines in case of failure. There is no traffic on the stand-by line before the failure, and switching will have to take place at both ends.

In the case of NMS re-routing, the network is generally built with extra capacity in the lines. In case of failure, the traffic from the failed line is re-routed on other lines. This operation is conducted by a network management system (NMS).

There are ring protection solutions that use the fact that any node in a ring may be reached in two ways. They mainly fall into two groups:

- Nodes in the ring keep an updated database of all nodes in the ring with information on which time slots belong to these nodes. When a fault occurs, the ring is split and time slots are selectively transmitted on

the right or left branch according to this information.

- When a fault occurs, information is sent to a central management system that decides on the re-configuration of the nodes in the ring.

PROBLEMS WITH KNOWN SOLUTIONS

The problem with the 1+1 protection has been that this is a very costly alternative as every line segment must be duplicated.

The N+1 solution is a limited solution since it can only protect a number of line segments between the same nodes.

The NMS re-routing solution is generally too slow for application requiring connections to stay up. For instance, the GSM traffic in cellular networks will go down if the protection is based on NMS re-routing.

The problem with existing ring solutions is that they generally are more complex and thus more expensive and subject to errors than the suggested ring solution. Also, in the case of needing to use a central management system for restoration, switching is not fast enough to be used in for instance cellular networks.

Objects of the invention

An object of the present invention is to provide a method for establishing alternative routes in a telecommunication network which generally is not hampered with the problems enfaced with known solutions.

Another object of the present invention is to provide a method which is less complex and less expensive as well

as less subject to errors than previously suggested ring solutions.

Still another object of the present invention is to provide a method wherein the use of a central management system for restoration is reduced to a minimum.

Yet another object of the present invention is to provide a method which is autonomously self healing, and wherein the healing is accomplished in a minimum of time.

Another object of the present invention is to provide a method wherein the self healing means are included in the nodes of the network.

Brief summary of the invention

These objects are achieved in a method as stated in the preamble, which according to the present invention is characterized by

- arranging said network in one or more initial rings including duplex operation between the nodes included in each ring, and by
- arranging said nodes such as to let all time slots be transmitted in one and the same direction (OK direction) of the ring in question whilst maintaining the opposite direction (ERROR direction) as a standby or redundancy path.

Further objects and advantages of the present invention will appear from the following description taken in conjunction with the enclosed drawings, as well as from the enclosed patent claims.

Brief disclosure of the drawings

Fig. 1 is a simplified sketch illustrating an initial protected ring wherein the present invention has been implemented.

Fig. 2 is a simplified sketch illustrating details in one of the nodes which are tied into the ring by dropping and inserting time slots.

Fig. 3 is a simplified sketch, similar to Fig. 1, illustrating the ring after switching to redundancy mode.

Fig. 4 is a simplified sketch illustrating a ring configuration before, during and after a transmission fault occurs.

Detailed description of embodiments

It is to be understood that the present invention has been developed in connection with 2 Mb/s transmission links which are always duplex, but it is to be understood that the general principle of the present invention can be applied in any telecommunication network comprising transmission links for duplex operation.

In Fig. 1 there is illustrated an example of a ring including 4 nodes, designated A, B, C, D, respectively. Such a ring may be included as one of more rings in a network and between each node in the ring in question there is established a duplex operation.

In the following it is assumed that the example of the ring illustrated in Fig. 1 is established for a 2 Mb/s transmission link.

2 MBit/s transmission links are always duplex. There is symmetrical transmission in both directions. This symmetrical nature of the 2 Mbit/s network makes it possible to set up a ring where all time slots are transmitted in one direction while the other direction is not used. The empty direction may then be used as a stand-by path. The initial ring is shown in Fig. 1. The normal direction is called the OK direction. The spare direction is called the ERROR direction.

By using bits in time slot 0, it is possible to monitor each 2 Mbit/s section in the ring for both directions. A transmission fault on a section can thus be detected at both ends and re-routing of the time slots to the spare capacity may be done in both affected nodes.

The fault criteria may be:

LIS - Loss of Incoming Signal
LFA - Loss of Frame Alignment
RAI - Remote Alarm Indication

For a cross-connect node, the timing information is usually taken from one of the incoming line signals. In the protected ring, timing is propagated along with the normal traffic direction. When the traffic switches, the timing will also have to switch.

Other nodes are tied into the ring by dropping and inserting time slots as shown in Fig. 2. Most of the time slots entering the node in the OK direction is fed right through the node. Time slots destined for the connected equipment are dropped off to the port where this equipment is connected. Time slots from the connected equipment is inserted into the OK direction thus keeping the one-way traffic in the ring.

If the ring should be treated as a sub-network connecting to a central node such as the BSC in cellular networks, all time slots would be dropped towards this node.

When a fault occurs on a section in the ring the two nodes in both ends of that section will be triggered by the switching criteria. The two nodes will then re-configure so that traffic that normally would be sent out on the faulted section will be routed back onto the ERROR direction. Traffic that normally would be taken from the faulted section will instead be taken from the ERROR direction. This is shown in Fig. 3 where the fault occurred between nodes C and D.

If, in Fig. 3, node D received timing information from node C, its timing source would have to change. This is trivial for node D because this node is next to the faulty section and is able to detect the switching criteria. However, had there been more nodes between nodes D and A, for example nodes DX, DY and DZ, these would also have to change timing sources. These nodes do not have access to the same fault information as have nodes D and C.

To make these nodes aware of the need to switch timing source, one of the spare bits in time slot 0 is used as a timing source bit. On ports used as timing source, this bit is sent in the high state. On all other ports the bit is sent in the low state. It is not legal to use a port with the incoming timing source bit in the high state as a timing source. As node D starts using the other (non faulty) port as timing source, the timing source bit will force the node at the other end to change timing source if timing previously was taken from node D. This will ripple through all possible nodes between nodes D and A until the complete rightmost branch takes timing from node A. Clock stability requirements secure that

the timing change information is transported before bit-slip will occur.

In other words when the node D immediately following the faulty section starts using the other non-faulty/redundancy channel port as timing source, then the timing source bit will force the next node DX in the redundancy ERROR direction to change its timing source if timing was previously taken from said next to fault node D, which forcing will take place also in any still further nodes DY, DZ arranged between said next to fault node D and said node A being connected to a central node CN.

In Fig. 4 there is illustrated another ring configuration between four other nodes R, S, T and U, wherein a transmission fault has occurred between the nodes S and T.

Fig. 4 further illustrates how ports used as timing source will send one of the spear bits in time slot 0 in the high state, whereas on all other ports this bit is sent in the low state. Further, Fig. 4 illustrates that when node S, due to a transmission fault, will have to use the redundancy or error path, it will establish its output port as a timing source, i.e. especially for the closest node R, which further communicates the redundancy path to node U and node T, in which latter node T the incoming of time slots on the redundancy port thereof will set the associated timing source bit to high state. This high state will be transferred from node T to node U, and further to node R, but then via the OK path, until the correct timing configuration is established.

Advantages

There are several advantages to this invention. They may be summarised as follows:

Usually redundancy creates largely increased costs due to duplication of transmission capacity. The suggested redundant ring only needs one extra section and the inherent spare capacity in duplex lines to protect a number of other sections and is thus less costly.

The switching of time slots and timing sources are completely autonomous and does not require any interaction with a remote management system. Switching is thus rapid and restoration of connections is done with minimum interruption of traffic.

Because only the two nodes in either end of the faulty section is actively involved in the switching, there is no need for additional complexity in order to synchronise other nodes in the ring with configuration information. The suggested solution is thus less complex, less expensive and more reliable.

Patent claims

1. Method for establishing alternative routes in a telecommunication network, especially in case of transmission failure, and more specifically in a telecommunication network comprising 2 Mbit/s transmission links and nodes with G.704 framing for duplex operation, wherein said network is arranged in one or more initial rings including duplex operation between the nodes included in each ring,
characterized by
- arranging said nodes, due to the symmetrical nature of the 2 Mbit/s network, such as to let all time slots be transmitted in one and the same direction (OK direction) of the ring in question whilst maintaining the opposite direction (ERROR direction) as a standby or redundancy path until alerted by a specific time slot reflecting the occurrence of a fault.

2. Method as claimed in claim 1,
characterized by providing a time slot, preferably time slot 0, with alertable means which are adapted to monitor each section in the ring in question for both directions, said alerting means being defined by the bit configuration of said time slot.

3. Method as claimed in claim 1 or 2,
characterized in that each node is provided with detection means adapted for detecting a section transmission fault both at the incoming or at the outgoing ports thereof, i.e. allowing detection of a transmission fault on a section at both ends of said section.

4. Method as claimed in any of the claims 1-3,
characterized by letting inter alia the following fault criteria determine the re-routing of the time slots:

LIS - Loss of Incoming Signal
LFA - Loss of Frame Alignment
RAI - Remote Alarm Indication

5. Method as claimed in any of the preceding claims,
c h a r a c t e r i z e d i n that during normal and initial ring operation the timing information will preferably be taken from one of the incoming signals, i.e. signals being propagated along the normal (OK) direction.

6. Method as claimed in any of the preceding claims,
c h a r a c t e r i z e d i n that when a fault occurs on a section in the ring the two nodes at the end of that faulty section will be triggered by one or more appropriate switching criteria, for thereby reconfiguring the two nodes in question for routing the traffic which should have been sent via the faulty section to its destination node or nodes via the duplex channel in the opposite (ERROR) direction.

7. Method as claimed in any of the preceding claims,
c h a r a c t e r i z e d i n that when a fault occurs in a section between two nodes then the node immediately following the faulty section in the previous normal (OK) direction will have its timing source changed upon detection of the appropriate fault occurrence switching criteria, and that any further node or nodes being arranged between said immediately following node and a node (A) being connected to a central node (CN) will also have its or their timing sources changed.

8. Method as claimed in claim 7,
c h a r a c t e r i z e d i n that one of the spare bits in time slot 0 is used as a timing source bit and that on ports being used as a timing source this bit will

be given a first state, preferably the high state, whereas all other ports will have the same spare bit sent in the opposite state, i.e. preferably the low state.

9. Method as claimed in claim 8, characterized in that when the node (D) immediately following the faulty section starts using the other non-faulty/redundancy channel port as timing source, then the timing source bit will force the next node (DX) in the redundancy (ERROR) direction to change its timing source if timing was previously taken from said next to fault node (D), which forcing will take place also in any still further nodes (DY, DZ) arranged between said next to fault node (D) and said node (A) being connected to a central node (CN).

10. Method as claimed in any of the preceding claims, characterized in that the transport of the timing change information sent or rippled through nodes involved in a redundancy (ERROR) path, i.e. receiving signals thereon but transmitting signals on the remaining normal (OK) path, is adapted in relation to clock stability requirement so as to avoid the occurrence of bit slip.

11. Method as claimed in any of the preceding claims, characterized in that the method is applied in an autonomous manner, without any interaction with a remote management system (RMS).

12. Method as claimed in any of the preceding claims, characterized in that the method is applied as an autonomous self healing ring, especially in a 2 Mb/s leased line telecommunication network so as to

create redundancy pathways therein in case of transmission failure.

FIG.1

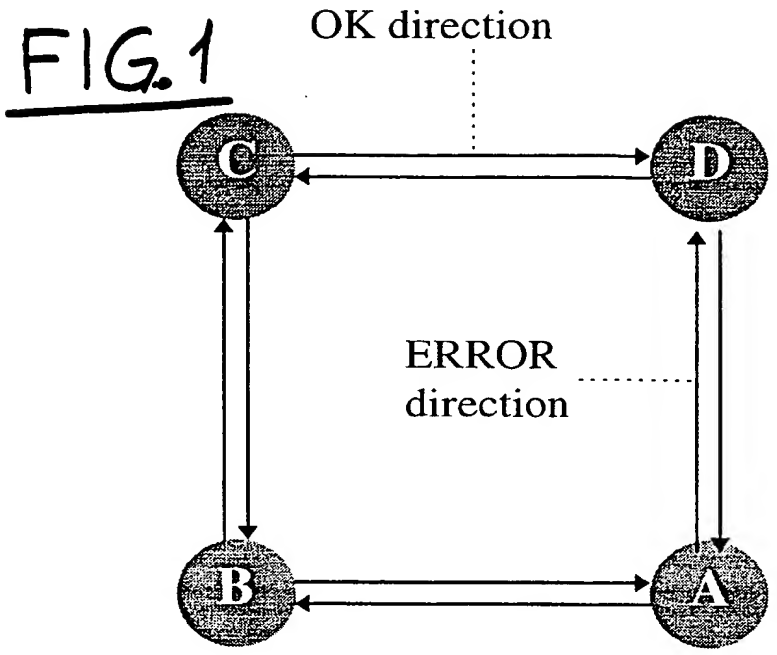
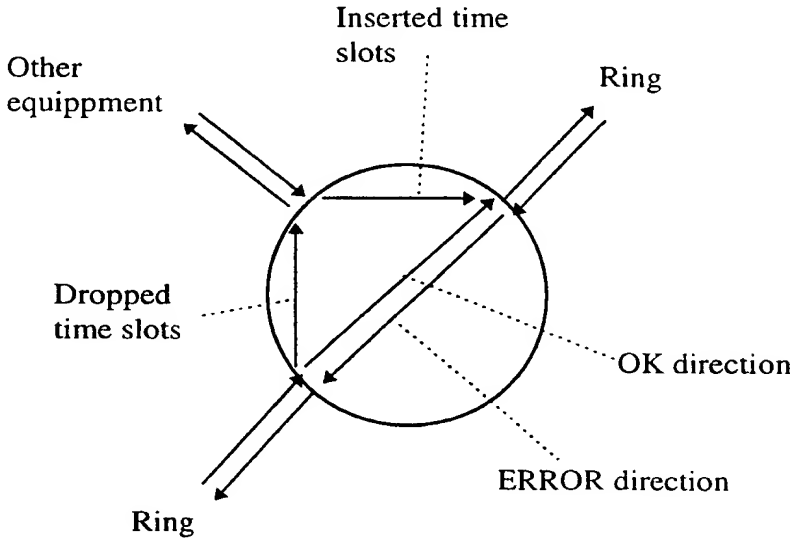

OK direction
C
D
ERROR
direction
B
A

FIG.2


Inserted time
slots
Other
equippment
Ring
Dropped
time slots
OK direction
ERROR direction
Ring

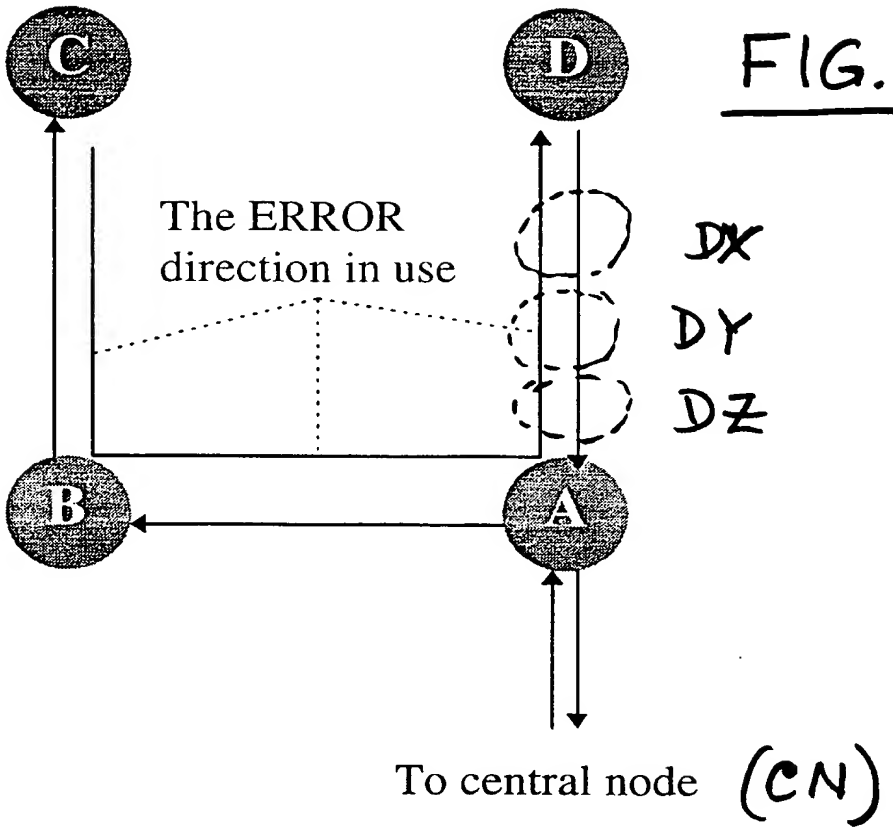
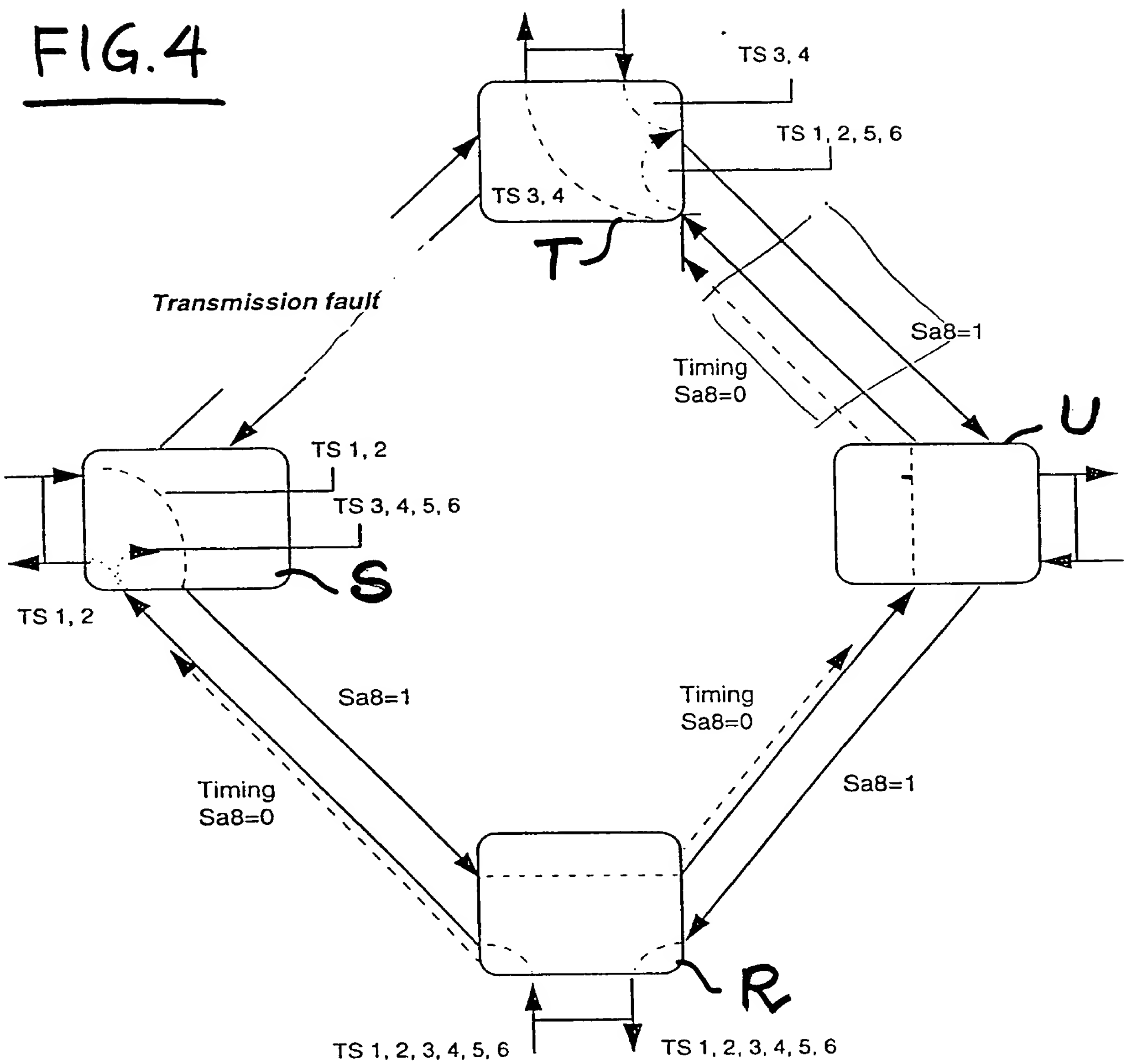


FIG.3

FIG.4



32 tidsluker
Tidsluke 0

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 98/00347

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04L 12/56
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04L, H04J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPIL, EDOC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9701907 A1 (TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)), 16 January 1997 (16.01.97), see the whole document	1
A		2-12
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X	EP 0370845 A1 (MATRA COMMUNICATION), 30 May 1990 (30.05.90), see the whole document	1
A		2-12
	--	
A	US 5636205 A (HIROYUKI SUZUKI ET AL), 3 June 1997 (03.06.97), see the whole document	1-12
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☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 Sept 1999	28 -09- 1999
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Malin Gullstrand/mj Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

Information on patent family members

30/08/99

International application No.
PCT/NO 98/00347

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